Salt River Bridge
(Valley Flower Bridge)
Dillon Road at Salt River
Ferndale Vicinity
Humboldt County
California

HAER No. CA-126

HAER
CAL,
12-FERDA.V,
1-

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

Historic American Engineering Record
National Park Service
Western Region
Department of the Interior
San Francisco, CA 94107

HAER
CAL,
12-FERDA.V,
1-

HISTORIC AMERICAN ENGINEERING RECORD

SALT RIVER BRIDGE (Valley Flower Bridge)

HAER No. CA-126

Location: Dillon Road at crossing of Salt River, Ferndale vicinity, Humboldt County, California.

UTM: 10-392253.4494367
Quad: Ferndale, Calif. 7.5'

Date of Construction: 1919.

Engineer: H.J. Brunnier, Consulting Engineer

Present Owner: Humboldt County
Department of Public Works
1106 Second Street
Eureka CA 95501

Present Use: Highway bridge.

Significance: The Salt River Bridge, also known as the Valley Flower Bridge, determined eligible for inclusion in the National Register of Historic Places in 1987, represents a major example of the work of a significant designer. When built in 1919, this was recognized as the world's longest reinforced concrete girder bridge, whose 142-foot spans were nearly twice as long as the previous longest concrete bridge girders.

Report Prepared By: John W. Snyder
Co-Principal
P.S. Preservation Services
P.O. Box 191275
Sacramento CA 95819

PART I. HISTORICAL INFORMATION

The Salt River Bridge was designed and built in 1919 to replace an earlier timber Howe pony truss bridge. That bridge had been the third permanent bridge at this site. The earliest crossing of the Salt River at this location was effected by use of a pontoon bridge built in 1880. This was a simple structure of logs fastened together with a plank deck. During periods of high water, one end would be cast adrift to allow the structure to pivot on the fastened end and drift against the bank, to be reattached after the flood subsided. This floating bridge required rebuilding in 1883, 1885, and 1886. Clearly, a better solution was required.

The American Bridge Company built the first permanent bridge at this site in 1886, but high water damaged its approach spans in 1890, resulting in its replacement in 1893. A flood in 1894 destroyed the second bridge, and the third structure was built shortly thereafter, but provided an additional five feet of clearance above the river. More substantially built as well, the third bridge withstood a major flood in 1906. By 1919, however, events of the previous thirty years had conspired to bring about changes which required yet another bridge at this crossing of the Salt River.

Settlement in this portion of the Eel River Valley saw the platting of Port Kenyon, just west of the bridge site, in 1876. The Coast Survey had applied the name to the shipping point on the land of John G. Kenyon, and the town became a significant point of shipment for local products from circa 1880 to circa 1910. Steamboats and schooners, most having a draft of eight to ten feet and a capacity of 100 to 150 tons, operated from Port Kenyon. Between 1885 and 1891, these vessels carried no less than 45,900 tons of lumber, shakes, shingles, grain, potatoes, butter and general produce to the markets of San Francisco. Up to 900 passengers rode the small ships annually. At this time, depth of the Salt River inland of Port Kenyon was as much as 20 feet. All this was to change rapidly under the hand of man.

Reclamation of the salt marshes for farming and grazing began about 1884, with the formation of a reclamation district. Up to 2,000 acres of marsh were diked and drained. One unintentional effect of these efforts, however, was a reduction in the tidal action necessary to keep the Salt River flushed; the river began to fill in. This siltation had a related cause as well: clearing of land for farming. Initially, the Salt River delta was a tangle of brush beneath an overstory of spruce and redwood trees. Ultimately, most of this vegetation was removed by 1900. As a result, each winter erosion added immense loads of silt to the river, abetted when the nearby Eel River overflowed into the Salt River drainage. Feeder creeks added their own loads of silt. By 1899 the river was but two feet where a decade earlier it had been ten times that depth. With tidal action obstructed by the reclamation dikes, the silt could only accumulate. By 1909, vessels were unable to reach Port Kenyon, and the era of water transportation in the Eel River Valley drew to a close.

Most of the reclamation efforts were linked to the expansion of the local dairy industry, which had begun as early as the 1860s in the nearby Bear River section. Danish and Swiss immigrant workers in the Bear River dairies later established their own dairies in the Ferndale/Port Kenyon area. Farmers formed cooperative creameries beginning in 1889, with more than a dozen built by about 1900. One of the later of these cooperatives was the Valley Flower Cooperative Creamery.

The Valley Flower Cooperative Creamery was organized on September 20, 1913 for the manufacture of butter and other dairy products. The creamery building was completed the following year, and the complex expanded over the next few years with the addition of buildings housing other functions: cold storage building in 1917; building for condensing milk in 1919; dry milk plant in 1924. The creamery operated successfully for more than 45 years, its success founded on sound financial management coupled with ready adaptation to technological advances, until at last the scale of technology outstripped the ability of the Valley Flower Cooperative Creamery to adapt.

But in the early years of operation, the Valley Flower Cooperative Creamery was noted for its high quality butter, and for high production rates: about 75,000 pounds of butter and 37,000 pounds of casein per month; in 1917 the creamery obtained a contract for 150,000 pounds of butter for the U.S. Navy. Unable to ship their product by water, the operators of the creamery were forced to turn to the roads, and to the adjacent bridge. It would seem, then, that the success of the Valley Flower Cooperative Creamery, resulting in increased heavy traffic (likely increased also by further orders during World War I) led directly to the need to replace the old timber bridge with a concrete bridge of greater carrying capacity.

The Humboldt County Board of Supervisors reached their decision to replace the timber bridge in 1918, and directed County Surveyor A.J. Logan to prepare specifications. Logan, who had worked with consulting engineer John Leonard on massive nearby Fernbridge in 1911, knew well the advantages of reinforced concrete, and selected that material for the new Salt River Bridge. He dismissed steel trusses from consideration due to salt-laden fogs common to the area; a steel bridge would require constant painting and other maintenance. Logan specified a girder bridge, as opposed to an arch bridge, for this location because that design provided greater horizontal clearance, and lower cost, estimating that a girder bridge would cost $135/ lineal foot as opposed to $160/lineal foot for an arch bridge. For the actual design of the bridge, Humboldt County contracted with consulting engineer H.J. Brunnier, of San Francisco. This arrangement was normal for the period.

In 1874 the State Legislature had adopted a program by which counties could establish road districts and levy taxes for road construction. In 1893 they passed a law requiring each county to seek the advice of its County Surveyor on bridge design. This latter law largely professionalized the County Surveyor position, and attracted trained bridge engineers to those positions. The 1907 Savage Act permitted counties to incur bonded indebtedness to fund road and bridge construction, further stimulating infrastructure improvements. Between about 1889 and 1910, counties often contracted-out the design of bridges, but by the latter date most County Surveyors were capable of handling most bridge design. The notable exception was the reinforced concrete bridge, the design of which--particularly in rural counties--remained the purview of a handful of specialists. H.J. Brunnier was among the more important of these specialists.

Born in Manning,Iowa on November 26, 1882, Henry John Brunnier was the son of Martyn [variously, Martin] Brunnier and Caroline (Meyers [variously Meyer]) Brunnier. His father engaged in farming, as a merchant, and as Mayor of Manning. Educated in the public schools of Manning, Henry entered Iowa State College in 1900.

After graduating from the Civil Engineering course at Iowa State in 1904, he gained employment with the American Bridge Company in their main plant at Ambridge, Pennsylvania. While in that employ, some of his more important executions included: the structural steel construction of the Washington Terminal, Washington, D.C.; Heurich Brewing Co.; and hoists, buildings, etc., for the Brazial Mining Co. In 1905 he moved to the New York Edison Company in New York City, where he designed power houses and sub-stations, such as New Waterside Station. Henry J. Brunnier married Ann Weideman of Lincoln, Nebraska on October 2, 1905. (Their only child, Henry J. Jr., born in 1907 and who attended Stanford University, died in an accident in 1935.)

In 1906 he moved again, this time to the Ford-Bacon & Davis Engineering Company, who sent him to their San Francisco office as a structural engineer on May 4, 1906, two weeks after the earthquake and fire, for the reconstruction of the United Railroad [street railway].

In 1908, Brunnier opened his own office in San Francisco's Monadnock Building as a structural engineer, remaining in that practice through the 1940s. In his private practice he designed the first concrete piers and seawalls for the San Francisco Harbor Commission. He designed the YMCA at San Diego, a building that attracted attention in engineering journals for its originality of design. Other design commissions included the Marston Department Store at San Diego, the American Can Company and Examiner Buildings at Los Angeles, and the Shredded Wheat Company's plant at Oakland. He patented a hanging fender for docks, and was called to Honolulu to install these fenders on the piers there. At Santa Cruz he designed a timber wharf extending 3,000 feet out in the open sea. Predictions were made that the wharf was impractical, years of service proved its seaworthiness.

In San Francisco, Brunnier handled the structural engineering for the for M.H. de Young Memorial Museum in Golden Gate Park, the Civic Center Library, the Gantner and Mattern knitting factory, the meat packing plant of the Virden Packing Company and numerous structures for the Standard Oil Company, including the Standard Oil office building. He also undertook structural design for the Sharon building [whereto he moved his offices] and other structures for the Sharon estate, the Balfour-Guthrie Building, the California Insurance Building, the Federal Reserve Bank Building, the Holbrook, Merrill & Stetson Warehouse, and several warehouses for the Haslett Warehouse Company. His work included harbor and terminal structures in Richmond and San Diego; miscellaneous structures for Humboldt and other counties; Johns-Manville, American Can Company, Barth Company, American Radiator Company, Hammond Lumber Company, Owens-Illinois Pacific Coast Company, the San Francisco Baseball Club and many others.

During World War I, Brunnier left his office on a twenty-four notice, went to Washington and, with Rudolph Wig, organized and managed the Concrete Ship Department for the U.S. Emergency Fleet Corporation [this was later to influence his design of the Salt River Bridge]. Following the 1925 Santa Barbara Earthquake, Brunnier was one of a team of engineers reporting on the effects of the temblor. In the 1930s, he was one of the five members of the Consulting Engineers' Board for the San Francisco-Oakland Bay Bridge. He also served as consulting engineer for the Low Level Broadway tunnels between Alameda and Contra Costa Counties, as well as consulting engineer for the Boards of Education of San Francisco, San Rafael, Redwood City, San Leandro, Helena, Montana, and the University of California in the reconstruction of buildings for earthquake safety.

His memberships included: American Society of Civil Engineers [served as President of San Francisco Section]; Pacific Association of Consulting Engineers [served as President]; Structural Engineers' Association of Northern California [served as President]; Engineers' Club of San Francisco [served as President]; Seismological Society of America, American Concrete Institute; Cardinal Guild (Iowa State College honor society), National Honorary College Engineering Fraternity, Tau Beta Pi; and the honorary Civil engineering fraternity, Chi Epsilon, at the University of California. He served as President of the State Board of Registration for Civil Engineers, and chaired several committees for the San Francisco Chamber of Commerce. Active in civic and affairs, he presided over the West of Twin Peaks Improvement Club's Council; the San Francisco Rotary Club, was District Governor and Vice President of Rotary International; was a Mason; presided over the California State Automobile Club and the Lake Merced Golf and Country Club; chaired the Highway Committee of California State Automobile Association and served as Director of the American Automobile Association.

The story now returns to Brunnier's San Francisco office, and to Humboldt County in 1918.

Brunnier provided a design which called for two spans, each 142 feet in length. These were to be half-through spans, with the deck carried approximately mid-height in the side girders. Because of the great length of the spans, the girders required great depth, no less than 12 feet. He placed transverse floor beams at 20-foot intervals, with intermediate longitudinal stringers carrying a 5-inch-thick concrete deck. Each main girder is seven inches thick in main section, enlarging by steps to a thickness of 24 inches at the top and 18 inches at the bottom. Opposite each floor beam, pilasters step up to a maximum width of 30 inches and a maximum thickness of 18 inches.

Brunnier's design was consistent with design loadings published in Ketchum's *Design of Highway Bridges*, and provided for a uniform live load of 70 pounds/square foot, or for a 15-ton road roller. Because of the likelihood of corrosion in the salt-laden air, Brunnier decided not to utilize steel roller bearings at the span ends, opting instead to pour a thin sheet of asphalt at each end and allowing four inches for expansion and contraction. Drawing on his experience in the design and construction of reinforced concrete ships mentioned above, Brunnier distributed steel reinforcing closely through the flanges of the girders, separating them with spacers. As in concrete ship construction, he directed the contractor to use a pneumatic hammer in concrete placement to compact the concrete and minimize rock pockets. (This was a fairly early use of this technique in bridge construction and, judging by the rock pockets visible in the abutments today, not entirely successful.)

Girder reinforcement was built to shape within the formwork. An opening left in the upper side of the bottom flange of the forms allowed placement of the reinforcement below that level, and each layer was fastened as it was placed. Brunnier also took no chances that the reinforcement might be improperly placed. He added an extra sheet to the plans, on which he plotted the length and location of each longitudinal bar in the top and bottom flanges of the girders. On this special sheet, not only was each run of steel identified by letter and number, but the exact length of each piece and its longitudinal position were also specified. Brunnier's careful attention to this detail ensured careful assembly of the reinforcing steel on the job site.

Construction began in April 1919, with Eureka contractor Thomas

Engelhart on site with a crew of men to stake out the alignment. Cost of the new bridge was estimated at $25,000. Newspapers reported building activities also at the adjacent Valley Flower Creamery which, as noted earlier, added impetus for construction of the new bridge.

The contractor first placed falsework, consisting of driven pile bents with sway bracing (similar to railroad trestle construction). A square timber capped each bent, and the form supports above the caps were shimmed so that the forms could be accurately aligned just before each pour of concrete. Brunnier had planned to carry on construction operations from both ends of the bridge, but the failure of the old bridge necessitated that the contractor work on the new structure from one end only.

As directed by Brunnier's plans, Engelhart's crew poured the concrete in five successive stages: the lower halves of the girders were poured first, then the floor system, and finally the upper halves of the main girders. In theory, this allowed the contractor to plan for suitable joints to be reached at the end of each day's pour. Engelhart poured half of each girder in one day, and the floor system in four sections in one day each.

Construction proceeded quickly, so that by June the Board of Supervisors ordered payment of $4000 to Engelhart for labor and supplies, following in July with a further payment of $3000. Following that entry, there is virtually no further mention of the bridge in local papers, except for a September 1919 article noting that the 1918 cost estimate was about $7000 low. Presumably the bridge was completed and accepted at about this time; in the end, the bridge cost totaled $25,250, only $250 over the estimate.

In 1937, State Highway engineers conducted their first inspection of the bridge, finding it in poor condition and with a 4-ton load limit. The main girders were by that time showing considerable cracking and some exposed reinforcing steel. The engineers considered none of this serious, but did note that the bridge approaches were dangerous because of poor sight lines (a condition which remains today). The next inspection of the bridge by State engineers occurred in 1980, which led to the bridge being posted for a 10-ton load limit (a stress analysis of the bridge, using modern calculations, confirmed Brunnier's original design stress assumptions).

PART III. SOURCES OF INFORMATION

BOOKS

Brunnier, H.J. *Engineers' Report, Santa Barbara earthquake, prepared by H.J. Brunnier, John G. Little, T. Ronneberg, for the Research Dept. of the California Common Brick Manufacturers' Association and allied interests.* San Francisco: Press of Schwabacher-Frey Stationery Co., 1925.

Davis' Commercial Encyclopedia of the Pacific Southwest, Ellis A. Davis, ed. Berkeley: Ellis A. Davis, 1911.

Gudde, Erwin G. *California Place Names.* Berkeley: University of California Press, 1969.

Mikesell, Stephen D. *Historic Highway Bridges of California.* Sacramento: California Department of Transportation, 1991.

Millard, Bailey. *History of the San Francisco Bay Region.* San Francisco: The American Historical Society, Inc., 1924.

Who's Who in California, 1939-1940. Los Angeles: Who's Who Publishing Co., n.d.

Who's Who on the Pacific Coast. Chicago: The A.N. Marquis Company, 1949.

PERIODICALS

"Longest Concrete Girder Bridge Is Built in California," *Engineering News-Record*, February 26, 1920.

"The World's Longest Concrete Girder Bridge," *The Architect and Engineer*, July 1920.

NEWSPAPERS

"Two Accidents at Creamery," *Humboldt Times*, April 1, 1919, p.6.

"Progress on Co. Highways and Bridges," *The Humboldt Times*, April 29, 1919, p.3.

"Engelhart Believes in Early Work," *The Humboldt Times*, May 11, 1919, p.14.

"Bull Creek, Mattole Road Ready in July," *The Humboldt Times*, June 20, 1919, p.12.

"Supervisors' Proceedings," *The Humboldt Times*, July 23, 1919, p.5.

"County Auditor Reports Detail of Proposed Co. Expenditures," *The Humboldt Times*, September 4, 1919, p.2.

REPORTS

Elliott, A.L. "Bridge Inspection Report, Salt River Bridge, Bridge No. 12." Sacramento, California Department of Transportation, August 10, 1937.

Higgins, D.R. "Order Establishing Load Limits on Bridge No. 4C-12, Salt River, on a Humboldt County Road." Sacramento, California Department of Transportation, January 29, 1981.

Schroeder, Gregg. "Revised Original Report, Salt River Bridge, Bridge No. 4C-12." Sacramento, California Department of Transportation, September 16, 1980.

PART IV. PROJECT INFORMATION

Humboldt County will construct a new bridge carrying Dillon Road across the Salt River in the Eel River Delta area, near Port Kenyon. The project will result in the removal of the existing bridge and the construction of the new two-lane bridge in approximately the same location. In addition, the project will realign Dillon Road at its junction with Riverside Road.

The new bridge is required to provide a structure capable of sustaining modern loads, providing two traffic lanes, and approaches which meet current standards. The existing bridge, constructed in 1919 across the Salt River and connecting Port Kenyon Road with Dillon Road, has provided access to outlying ranches for more than 70 years. Today, the existing bridge is structurally and geometrically deficient. In January 1981 the Humboldt County Board of Supervisors ordered the bridge posted for a live load limit of 10 tons. The bridge has numerous cracks which have developed as a result of cold joints between the various pours of concrete during its construction. The bridge is a one-lane structure, 15-1/2 feet wide between its railings, which are so high as to obstruct sight distance making entering and exiting the bridge's south end difficult. The narrow width of the bridge does not provide sufficient room for a pedestrian walkway. The alignment and grade at the north end of the existing bridge are substandard, and the vertical curves of both approaches do not afford enough sight distance for safe passage.

The new bridge will be a two-span, prestressed, cast-in-place concrete girder structure, 300 feet long and 28 feet wide. The new bridge will have a slightly higher soffit than the existing bridge, to allow for a one-foot clearance above the established flood water surface. The estimated cost of the entire project is $1,080,000.00.